

# PROCESS FOR MAINTAINING ONGOING REGISTRATION FOR PAGES ON A GIVEN SEARCH ENGINE

## FIELD OF THE INVENTION

The present invention relates to the process of developing and maintaining the content of Internet search engine databases.

## BACKGROUND OF THE INVENTION

An internet (including, but not limited to, the Internet, intranets, extranets and similar networks), is a network of computers, with each computer being identified by a unique address. The addresses are logically subdivided into domains or domain names (e.g. ibm.com, pbs.org, and oranda.net) which allow a user to reference the various addresses. A web, (including, but not limited to, the World Wide Web (WWW)) is a group of these computers accessible to each other via common communication protocols, or languages, including but not limited to Hypertext Transfer Protocol (HTTP). Resources on the computers in each domain are identified with unique addresses called Uniform Resource Locator (URL) addresses (e.g. http://www.ibm.com/products/laptops.htm). A web site is any destination on a web. It can be an entire individual domain, multiple domains, or even a single URL.

Resources can be of many types. Resources with a ".htm" or ".html" URL suffix are text files, or pages, formatted in a specific manner called Hypertext Markup Language (HTML). HTML is a collection of tags used to mark blocks of text and assign meaning to them. A specialized computer application called a browser can decode the HTML files and display the information contained within. A hyperlink is a navigable reference in any resource to another resource on the internet.

An internet Search Engine is a web application consisting of

1. Programs which visit and index the web pages on the internet.
2. A database of pages that have been indexed
3. Mechanisms for a user to search the database of pages.

Agents are programs that can travel over the internet and access remote resources. The internet search engine uses agent programs called Spiders, Robots, or Worms, among other names, to inspect the text of resources on web sites. Navigable references to other web resources contained in a resource are called hyperlinks. The agents can follow these hyperlinks to other resources. The process of following hyperlinks to other resources, which are then indexed, and following the hyperlinks contained within the new resource, is called spidering.

The main purpose of an internet search engine is to provide users the ability to query the database of internet content to find content that is relevant to them. A user can visit the search engine web site with a browser and enter a query into a form (or page), including but not limited to an HTML form, provided for the task. The query may be in several different forms, but most common are words, phrases, or questions. The query data is sent to the search engine through a standard interface, including but not limited to the Common Gateway Interface (CGI). The CGI is a means of passing data between a client, a computer requesting data or processing and a program or script on a server, a computer providing data or processing. The combination of form and script is hereinafter referred to as a script application. The search engine will inspect its database for the URLs of resources most likely to relate to the submitted

query. The list of URL results is returned to the user, with the format of the returned list varying from engine to engine. Usually it will consist of ten or more hyperlinks per search engine page, where each hyperlink is described and ranked for relevance by the search engine by means of various information such as the title, summary, language, and age of the resource. The returned hyperlinks are typically sorted by relevance, with the highest rated resources near the top of the list.

The World Wide Web consists of thousands of domains and millions of pages of information. The indexing and cataloging of content on an Internet search engine takes large amounts of processing power and time to perform. With millions of resources on the web, and some of the content on those resources changing rapidly (by the day, or even minute), a single search engine cannot possibly maintain a perfect database of all Internet content. Spiders and other agents are continually indexing and re-indexing WWW content, but a single World Wide Web site may be visited by an agent once, then not be visited again for months as the queue of sites the search engine must index grows. A site owner can speed up the process by manually requesting that resources on a site be re-indexed, but this process can get unwieldy for large web sites and is in fact, a guarantee of nothing.

Many current internet search engines support two methods of controlling the resource files that are added to their database. These are the robots.txt file, which is a site-wide, search engine specific control mechanism, and the ROBOTS META HTML tag which is resource file specific, but not search engine specific. Most internet search engines respect both methods, and will not index a file if robots.txt, ROBOTS META tag, or both informs the internet search engine to not index a resource. The use of robots.txt, the ROBOTS META tag and other methods of index control is advocated for the purposes of the present invention.

Commonly, when an internet search engine agent visits a web site for indexing, it first checks the existence of robots.txt at the top level of the site. If the search agent finds robots.txt, it analyses the contents of the file for records such as:

```
User-agent: *
Disallow: /cgi-bin/SRC
Disallow: /stats
```

The above example would instruct all agents not to index any file in directories named /cgi-bin/SRC or /stats. Each search engine agent has its own agent name. For example, AltaVista (currently the largest Internet search engine) has an agent called Scooter. To allow only AltaVista access to directory lavstuff, the following robots.txt file would be used:

```
User-agent: Scooter
Disallow:
User-agent: *
Disallow: /avstuff
```

The ROBOTS META tag is found in the file itself. When the internet search engine agent indexes the file, it will look for a HTML tag like one of the following:

```
<META NAME="ROBOTS" CONTENT="NOINDEX, NO FOLLOW">
<META NAME="ROBOTS" CONTENT="NOINDEX, FOLLOW">
<META NAME="ROBOTS" CONTENT="INDEX, NO FOLLOW">
<META NAME="ROBOTS" CONTENT="INDEX, FOLLOW">
```

INDEX and NOINDEX indicate to all agents whether or not the file should be indexed by that agent. FOLLOW and

NOFOLLOW indicate to all agents whether or not they should spider hyperlinks in this document.

For current internet search engines, the present invention process uses the CGI program(s) provided by the search engine in order to add, modify and remove files from the search engine index. However, the process can generally only remove a file from the search engine index if the file no longer exists or if the site owner (under the direction of the process) has configured the site, through the use of robots.txt, the ROBOTS META tag or other methods of index control, so that the search engine will remove the file from its index.

The duration of time between the first time a site is indexed and the next time that information is updated has led to several key problems:

- A. A resource that is modified or removed by its owner after it is indexed by a search engine could be incorrectly listed in that search engine for months until an agent visits the site to register the change.
- B. A resource may be modified since the last time it was indexed, in which case a user may never be directed to the new content, or incorrectly directed to content that is no longer present.
- C. Deleted resources can create the impression for a search engine user that a whole web site has shut down, that the information the user is looking for is removed, or that the web site is not being maintained, when the resources may have simply been moved to another location on the site as part of regular site maintenance.
- D. Automated tools such as search engines apply their own criteria in order to determine the relevancy of a particular resource for a particular query. These automated criteria can lead to the search engine returning spurious, misleading, or irrelevant results to a particular query. For example, a recent search for the nursery rhyme "Rub a dub dub, three men in a tub" on a particular search engine resulted in the top ten search results containing discussions of various issues among consenting males.
- E. Automated agents are not always able to understand the context of the pages they index, as illustrated by the example above. As such, their one-dimensional capabilities allow web masters to create the impression that the resources on a particular site contain information they do not. This is done to direct traffic to sites by providing incorrect or misleading information, a process called spamming.
- F. Most automated agents are incapable of processing the content of resources that are binary in nature, such as applications written in the programming language Java. These applications can display text data, but do not use text or HTML files to do so. Instead, the information is encoded in binary form in the application. As such, an agent cannot determine the content of a resource coded in this manner.

The present invention provides a mechanism for search engine and web site managers to maintain as perfect a registration of web site content as is possible. By augmenting or replacing existing agents and manual registration methods with specialized tools on the local web site (and, when feasible, at the search engine), the current problems with search engine registration and integrity can be eliminated.

#### SUMMARY OF THE INVENTION

The present invention defeats the key problems with automated agents and manual registration and replaces them

with an exception based, distributed processing system. Instead of making the search engine do all the work necessary to index a site, the web site owner is now responsible for that operation. By distributing the work, the search engine is improved in these ways:

1. The search engine can maintain perfect ongoing registration and indexing of pages by re-indexing at a set interval, as frequently as the web site owner chooses.
2. The search engine can maintain an intelligent database, not limited by the conditions that automated agents have imposed on them and not easily corruptible by web site owners with less ethical practices.
3. The search engine provides a guarantee of integrity to all users, ultimately providing a more valuable service to both users and web site owners.

The process is begun by distributing a set of search engine update software tools to the web site owner. These tools can be implemented in one of three ways. The first way is to implement the tools on the web server of the site owner. The software can run automatically, having direct access to all resources on the web site. The second way is to install the software tools on a surrogate server. This surrogate is a computer with proper permissions and access to the resources of the web site and automatically accesses those resources over the network. The third way is through the use of client-side tools. The software will run on each client's computer, check the client's web server via internet protocols, and relay the information on the web server to the search engine.

The software could be written in a variety of different programming languages and would be applicable for as many client and server computers as needed.

Upon initial execution, the software builds a database of the resources on the web site. The resources catalogued can be specified by the user, or automatically through spidering functions of the software. The database consists of one record per resource indexed on the site. Each record contains fields including:

- A. The search engines the owner of the web site would like the resource to be indexed by.
- B. The date and time of the last index by each search engine.
- C. The date and time a resource was last modified according to the local indexing engine.
- D. Flags to indicate whether a specific resource requires updating, inclusion, or removal from a particular search engine database.

Upon each subsequent execution the software tools inspect the current state of the web site against the content of the database. When altered, removed, or additional content is found, the software tools make the appropriate changes to the database and then notify the search engine of those changes (see FIG. 1, Box 206a, 207b-c). Changes to the database are made as follows:

- A. A resource is marked as deleted if the resource is listed in the current database, but cannot be retrieved.
- B. A resource is marked as modified if the date and time of last modification in the current database is earlier than the date and time of last modification provided by the web server for the resource.
- C. A resource is added and marked as added if it is present on the web server, but not yet in the database and the web site manager has opted to add it either manually or automatically.

Through application of the present invention, the following improvements are made in search engine administration:

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1. The task of spidering the web site has been distributed to the web site owner (see FIG. 1, Box 205c).
2. The web site owner has the capability to protect brand image from being injured by a search engine pointing potential visitors to deleted, irrelevant, or incorrect resource information.
3. The search engine owner has a higher degree of database integrity. Less information storage space is wasted on spurious, nonexistent or incorrect data.
4. The web site owner can directly indicate the keywords and other descriptions that are most appropriate for each resource in the site, as opposed to using the cumbersome HTML 'Meta' tag to specify the keywords for the agent. Keywords are words that are particularly relevant to a particular resource and might be used on a search engine to locate that resource.
5. The search engine can create a reverse index of keywords that the individual site owners have identified for each resource. For example, a user could query for a list of all web sites that have listed 'dog' as an appropriate keyword.
6. The internet search engine could be used by users to query the content of a particular web site, as opposed to requiring a web site based search engine to index the content. This saves administration effort and computing resources at the web site.

The main aspect of the present invention is to provide a method to index locally at a web site all changes to that site's resource content database which has occurred since the last search engine indexing.

Another aspect of the present invention is to actively transmit said changes to an internet search engine.

Another aspect of the present invention is to automatically transmit batches of updates (a list of content that has changed since the last search engine index), in a predetermined manner.

Other objects of this invention will appear from the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

#### BRIEF DESCRIPTION OF THE FIGURES

FIG. 1 is a flowchart of the steps to select which search engines will receive updates and which files shall be updated on those search engines

FIG. 2 is a diagram of the decision tree for determining the state of a specific resource on a particular search engine database, and the action needed to update the internet search engine as enabled in FIG. 1.

FIG. 3 is a diagram of the Internet search engine update process of updating the files as in FIG. 1 and resources defined by FIG. 2.

Before explaining the disclosed embodiment of the present invention in detail, it is to be understood that the invention is not limited in its application to the details of the particular arrangement shown, since the invention is capable of other embodiments. Also, the terminology used herein is for the purpose of description and not of limitation.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention can be used on new Internet search engine systems, or existing systems can be adapted for use by existing search engines having the following characteristics:

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1. The search engine provides a Common Gateway Interface to allow resources to be added to, modified, or deleted from the search engine database.
2. The search engine can update the database index quickly (ideally immediately) in response to additions, modifications, or deletions information provided through the CGI.
3. The search engine can keep the date and time it last indexed a page (or alternatively, the last modification date and time of the page when it was last indexed) and can make this information available to the web site owner.

In addition, if a search engine allows search results to be constrained to one particular site, that completes the functionality requirements of the present invention.

The technical effort required to apply the present invention to existing Internet search engines is similar to that required to apply the invention to a new search engine. The most complex instance would be to apply the invention to a range of search engines, some of which have been designed with the invention in mind, some of which have not. The aforementioned instance will be assumed here.

As implemented, the invention is a server-side process, running either on a surrogate server or the actual server upon which the web site is stored. The process is coded as a program in the Perl programming language, although other languages such as C++ or Java could be used. The process is invoked regularly by the operating system of the computer on which the program resides or manually by a web site manager.

As such, there are three main areas of the preferred embodiment that need to be understood. They are:

- I. The implementation and construction of the server side tools, which consist of the database and tools to update the database.
- II. The process by which the database is constructed and updated.
- III. The process by which a search engine is updated by a site using this process.

#### I. The Implementation and Construction of the Server Side Tools, Which Consist of the Database and Tools to Update the Database

Installation of the software tools places a number of CGI scripts, database tables, and HTML forms on the server. Each element performs a specific function relevant to the process and is outlined below. Initially, there is a database Table of Search Engines, containing an entry for each Internet search engine. The table below illustrates the format of a typical search engine record.

Field	Type	Default	Description
Name	String	None	The name of the search engine
Enabled	Boolean	True	Whether the search engine is to be informed of changes to content
Table of Files	Table	None	Database table of files indexed on this site and for which changes must be tracked
Register by default	Boolean	True	Whether to register a resource on this search engine in the absence of explicit information provided by the site manager
Max registrations	Integer	None	The maximum number of registrations allowed per day by this search engine

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Field	Type	Default	Description
Limit to site	Boolean	None	Whether the search engine allows searches to be restricted to one web site only
Lists index date	Boolean	None	Whether the search engine will report the date a resource was last indexed
Lists index time	Boolean	None	Whether the search engine will report the time a resource was last indexed
Index time	Integer	None	Typical delay between registration time and indexing of a site by the search engine
Supports file lookup	Boolean	None	Whether the search engine will allow a particular file to be searched for

The user is provided with an *HTML form and CGI script*, hereinafter referred to as a CGI program, in order to configure the Enabled and Table of Files fields (see FIG. 1, Box 100-101). The information the user inputs is submitted over the Common Gateway Interface (FIG. 1, Box 102) and the referenced CGI script updates the database tables as instructed (FIG. 1, Box 103-105). The user can thus enable (i.e., select) and disable a particular search engine using this interface. A search engine that is disabled in the database is simply skipped during an update.

The Table of Files is a field in the Table of Search Engines database. It is initially configured by the user through a CGI program (FIG. 1, Box 200) to list the files the user wishes to be registered with this search engine. This table contains a record for each resource. Each record contains the following fields:

Field	Type	Default	Description
Name	String	None	The URL of the resource
To Be Registered	Boolean	False	Whether the resource needs to be registered with this search engine
To Be Un-registered	Boolean	False	Whether the resource needs to be unregistered (removed) from this search engine
Date and time last registered	Date and Time	None	Date and time the file was last registered with the search engine
Register	Enum (True, False, By default)	By default	Whether the site manager wants the file to be registered on this search engine. The 'By default' value indicates to follow the value of the 'Register by default' field of the search engine record of the database

The Table of Files is a list of the above records. The list is built by first obtaining the set of resources the user wishes to maintain and register with a search engine (FIG. 1, Box 201). The user enters the files they wish to monitor into a CGI program and submits the form (FIG. 1, Box 203a-c, Box 204a-c). The form allows the user to choose from many methods of building the Table of Files. These methods include, but are not limited to:

- The user may list all the resources to be registered manually. These listed resources are added to the Table of Files (FIG. 1, Box 202a, 205a).
- The user may specify a map page. If the user specifies a map page, this map page is retrieved. All of the hyperlinked resources on the map page referring to this web site are added to the Table of Files (FIG. 1, Box 202b, 205b, 206b).
- The user may specify entry points to the web site. If the user specifies entry points, the CGI program will enter the site and spider to all resources referenced on those

entry points, adding those resources to the Table of Files (FIG. 1, Box 202c, 205c, 207c).

The list of pages built by the above process forms the Name fields of the Table of Files records for each search engine. This process can be performed globally (on all search engines in the table of search engines), on a group of search engines, or on an individual search engine, as indicated by the user (FIG. 1, Box 206a, 207b, 207c).

Submitting the above form also invokes a CGI script to set the Enabled and 'Register by default' fields of the appropriate search engine record according to the preferences of the user. Additionally, a page is provided where the title, URL and Meta Description of each page would be substituted in the appropriate place in the table for each search engine.

Submitting this additional information invokes a CGI script to set the Register field of the Table of Files field for the appropriate search engine record, according to preferences of the user.

#### IV. The Process by Which the Database is Constructed and Updated

The process now looks up each file and determines whether the file is registered, current, out of date, or deleted with respect to its registration on the search engine.

There are eight possible states for the file to be in with respect to its registration. In order for the process to be deterministic, all random spidering activity by the search engine is ignored in determining the state of the file. The state is determined purely by the current registration and the data the process has stored in the database of activities performed by previous invocations of itself.

FIG. 2 illustrates the decision process to determine the state of a resource on the search engine (Box 1) and the action, which must be taken. A resource can be in the following states:

Deleted (2a)	The resource no longer exists on the web site. If the resource exists in the search engine database, an error is signaled.
Awaiting indexing (2b)	The resource is not in state 2a. The resource should shortly be indexed by the search engine and should not be registered now.
Out of date (2c)	The resource is not in state 2a, 2b . . . The resource is not due to be indexed by the search engine, but has been modified since it was last indexed by the search engine.
Well registered (2d)	The resource is not in state 2a, 2b, 2c. The resource has not been modified since last indexed and its listing on the search engine is correct.
Wrongly registered (2e)	The resource is not in state 2a, 2b, 2c, 2d. The resource is listed on the search engine, but the web site manager does not want it to be.
Wrongly unregistered (2f)	The resource is not in state 2a, 2b, 2c, 2d, 2e. The web site manager wishes the resource to be registered by the search engine, but the resource is not registered by the search engine or due to be indexed by the search engine.
Correctly unregistered (2g)	The resource is not in state 2a, 2b, 2c, 2d, 2e, 2f. The resource is not registered, not due to be indexed, and the user does not wish it to be.
Will be indexed in error (2h)	The resource is not in state 2a, 2b, 2c, 2d, 2e, 2f, or 2g. The resource is not listed by the search engine and the site manager does not wish it to be. However, the file will shortly be indexed by the search engine and the site configuration currently would not prevent this.

The following are the actions to be taken in each state (see FIG. 2):

Deleted (3a)	The resource no longer exists on the web site. The process attempts to remove the resource entry from the search engine database with a CGI program provided by the engine for this purpose (4a).	5
Awaiting indexing (3b)	No action is taken.	
Out of date (3c)	The resource has been modified since it was last indexed by the search engine. The process attempts to register the resource for re-indexing with CGI program provided by the engine for this purpose.	10
Well registered (3d)	No action is taken.	
Wrongly registered (3e)	The process attempts to remove the resource entry from the search engine index using a CGI program provided by the search engine for this purpose.	15
Wrongly unregistered (3f)	The process attempts to add the resource to the search engine index using a CGI program provided by the search engine for this purpose.	20
Correctly unregistered (3g)	No action is taken.	
Will be indexed in error (3h)	The web site manager is warned though the process reporting mechanism (e-mail, a web page, or other method) that the manager does not want the resource to be indexed, but the search engine will shortly index it and there are no safeguards in place to prevent this. Site manager can take appropriate steps to avoid registration (4b) or registration will take place (4c).	

The following psuedo code indicates the necessary steps in programming which must be taken determine the state of a resource and take the appropriate action.

```

For each enabled search engine in DatabaseLookup(table of
search engines)
  list of files = search engine.table of files
  If search engine.limit to site
    search engine files = SearchEngineLookup(all files
reported by search engine for this site)
    list of files = list of files + search engine files
  End If
  For each file in list of files
    last index date time = GetIndexDateTime(file, search engine)
    If FileExists(file, list of files)
      If search engine.table of files.file.toberegistered
        RegisterFile(file, search engine)
        Next For [each file in list of files]
      End If
      last modification date time =
        GetLastModificationDateTime(file)
      will be indexed = WillBeIndexed(file, search engine,
last index date time)
      should be registered = ShouldBeRegistered(file,
search engine)
      If last index date time != not found
        If should be registered
          If last modification date time >
last index date time
            If will be indexed
              AddReport("awaiting
indexing", file)
            Else
              AddReport("out of date",
file)
              RegisterFile(file,
search engine)
            End If
          Else
            AddReport("well registered",
file)
          End If
        End If
      End If
    End If
  End For
End For

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Else [File is registered but should not bc]
  AddReport("wrongly registered", file)
  UnRegisterFile(file)
End If
Else [File is not registered]
  If should be registered
    AddReport("correctly unregistered", file)
    RegisterFile(file, search engine)
  Else
    If will be indexed
      AddReport("will be indexed in error",
file)
    Else
      AddReport("well unregistered",
file)
    End if
  End If
End If
Else [File Does not exist]
  AddReport("deleted", file)
  If last index date time != not found
    UnRegisterFile(file, search engine)
  End If
End If [File Exists]
End For
End For

```

### III. The Process by Which a Search Engine is Updated by a Web Site Using This Process

There are three ways the process may update a search engine:

1. It can register a resource in an attempt to have that file added to the search engine database (FIG. 3, Box 104).
  2. It can register a resource in an attempt to update the resource's listing in the search engine database (FIG. 3, Box 105).
  3. It can unregister a resource in an attempt to remove the file from the search engine index (FIG. 3, Box 103).
- In practice, these three activities are usually performed by the same CGI program on current search engines. This CGI program is the 'register file' program and is run manually by the user or automatically (FIG. 3, Box 100). An HTML form is provided for the purpose of adding a resource to the search engine index. On submitting the form, a CGI script is invoked. The most common mode of action for this script is as follows:
1. If the file exists (FIG. 3, Box 101), the search engine determines whether the configuration of the web site will allow indexing through robots.txt and/or ROBOTS Meta Tag (FIG. 3, Box 104). If the file does not exist and the file has been registered by the search engine (FIG. 3, Box 101, 102), it is removed immediately from the search engine database index (FIG. 3, Box 103).
  2. If the site can be indexed, the search engine determines if the resource is registered by the search engine. If the resource is registered, the search engine determines if the resource has changed since it was last indexed (FIG. 3, Box 109). If the resource has changed since it was last indexed, the resource entry in the search engine database is updated with new data (FIG. 3, Box 109, 110). If the resource has not changed since it was last indexed, then no action is taken. (FIG. 3, Box 111). If the site can not be indexed, and the resource has been indexed by the search engine (FIG. 3, Box 105), the entry for the resource is removed from the search engine database (FIG. 3, Box 106).
  3. In a case where the site can be indexed and the resource does not exist in the search engine database, the

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resource URL is added to a list of URLs the search engine will index (FIG. 3, Box 108). Some search engines will index resources submitted in this way within a day or two of submission. Other search engines may take weeks or months.

The Following Psuedo Code Illustrates the Above Processes:

```

On RegisterFile(file, search engine)
  Check that the file is appropriate for the search engine
  If file is appropriate or IsRegistered(file, search engine)
    If file is not appropriate
      AddReport("inappropriate file registered", file)
    End If
    If(file in DatabaseLookup(search engine, table of files))
      AddFileToDatabase(search engine, file)
    End if
    If SearchEngineRegistrationsOK(file, search engine)
      SearchEngineRegisterFile(file)
      If file registered OK
        search engine.table of files.file.date last
          registered = today's date
        search engine.table of files.file.time last
          registered = now
        AddReport("file registered", file)
        search engine.table of files.
          file.toberegistered = false
      Else
        AddReport("Registration failed", file)
        search engine.table of files.
          file.toberegistered = true
      End if
    Else
      AddReport("registration delayed", file)
      search engine.table of files.file.
        toberegistered = true
    End if
  Else
    AddReport("registration failed - inappropriate file", file)
  End if
End RegisterFile
On UnRegisterFile(file, search engine)
  SearchEngineUnRegisterFile(file)
  If file unregistered OK
    AddReport("file unregistered", file)
    search engine.table of files.file.tobeunregistered = false
  Else
    AddReport("Unregistration failed", file)
    search engine.table of files.file.tobeunregistered = true
  End if
End UnRegisterFile

```

The present invention would:

1. Significantly improve the quality of a sites registration on a range of search engines. Out of date registrations and registrations pointing at deleted files would be quickly cleaned up. Unregistered files that the site owner wanted registered would be quickly registered, and currently indexed files that the site owner wanted removed from the index would quickly be removed. Registration would always be within the rules of each search engine to which the process was applied.
2. Provide a new method for search engines to gather and distribute information. The process works best when the search engine and site owner cooperate for mutual benefit. The search engine should offer the following features in order for the process to work most efficiently:
  - a. Provide confirmation that a particular file is in the index.
  - b. Provide the date and time the file was indexed or guarantee immediate indexing
  - c. Provide the current date and time according to the search engine index

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- d. Provide a means to add a file to the index (ideally immediately)
- e. Provide a means of removing a file from the index (ideally immediately)
- f. Impose no practical limit on the number of files that may be registered within a fixed period
- g. Provide a means of restricting searches to a particular site through a hidden field in the search CGI, the state of which is maintained on each page delivered by the search engine. Once a site has a perfect ongoing registration on a powerful search engine, that search engine is perfect for searches within that site.

The following functions are describe further the above processes.

```

On DatabaseLookup(table of search engines)
  return table of search engines
End DatabaseLookup(table of search engines)
On DatabaseLookup(search engine, table of files)
  return table of files(search engine)
End DatabaseLookup(search engine, table of files)
On AddFileToDatabase(search engine, file)
  table of files(search engine) += file
End AddFileToDatabase(search engine, file)
On SearchEngineLookup(all files reported by search engine for site)
  list of files = ( )
  page number = 1
  site links = SearchEngineGetPage(search engine,site, page number)
  while number of site links > 0
    list of files += site links
    increment page number
    site links = SearchEngineGetPage(search engine,
                                     site, page number)
  end while
  return list of files
End SearchEngineLookup(all files reported by search engine for site)
On FileExists(file, list of files)
  If file is local
    Perform stat of file
    return stat.exists
  else
    Perform HTTP head request of file
    If head request indicates that file exists
      Return file exists
    else
      Return file not exists
    end if
  end if
End FileExists(file)
On GetLastModificationDate(file)
  If file is local
    Perform stat of file
    return stat.LastModificationDate
  else
    Perform HTTP head request of file
    return response.LastModifiedDate
  end if
End GetLastModificationDate(file)
On GetIndexDateTime(file, search engine)
  If search engine.lists index date
    If search engine supports file lookup
      If(!LookupFile(search engine, file))
        last index date time = not found
      Else
        last index date time = lookup.date
        If search engine.lists index time
          last index date time += lookup.time
        End if
      End If
    Else
      last index date time = not found
    For each phrase in file
      While GetNextSearchEnginePage(search engine,
                                     phrase)
        If search engine page lists file

```